

EXECUTIVE SUMMARY

Diesel vehicles, including both onroad and nonroad vehicles, emit significant amounts of nitrogen oxides (NO_x) and particulate matter (PM). In 2005, nonroad diesel construction vehicles were estimated to emit annual U.S. national totals of 657,000 tons of NO_x and 63,000 tons of PM₁₀. In recent years, the U.S. Environmental Protection Agency (EPA) has set Tier 1 to Tier 4 emission standards for the engines used in most construction, agricultural, and industrial vehicles.

The North Carolina Department of Transportation (NCDOT) has been using B20 biodiesel in its inventory of diesel vehicles, including onroad and nonroad, in order to comply with the Energy Policy Act. Based on engine dynamometer testing, the typical expectation is that the use of B20 biodiesel leads to a small increase (i.e. 2%) in tailpipe NO_x emission rates, but decreases of 10% for PM, 11% for CO, and 21% for hydrocarbon (HC) tailpipe emission rates.

In previous work, we have assessed the effect of B20 versus petroleum diesel with respect to tailpipe emissions of selected Tier 1 and Tier 2 dump trucks, including both single rear axle and tandem chassis configurations. The average NO emission rate, among 12 vehicles tested, decreased by approximately 10%. The observed average decreases in CO, HC, and PM emission rates were very similar to those of the dynamometer tests.

Emissions from nonroad construction equipment are typically quantified based on steady-state engine dynamometer tests. However, such tests do not represent actual duty cycles. There is a need for more representative data based on real-world vehicle activity.

There has been limited in-use testing of nonroad vehicles using a variety of instruments. Some of these data are proprietary, some are limited in scope (e.g., measurement of only two pollutants), and some are reported only in summary form. Furthermore, these data do not address the desired scope of comparison of multiple Tiers of engine regulations nor do they address a comparison of B20 versus petroleum diesel fuel.

The purpose of this project was to conduct field measurements of selected nonroad vehicles in the NCDOT equipment inventory in order to gain insight into the real world implications for emissions of increasing stringent Tiers of engine regulations and of the substitution of soy-based B20 biodiesel for petroleum diesel. Such insights are useful when evaluating the benefits of replacing older vehicles with newer ones or when purchasing an alternative fuel for which there is currently a cost premium compared to conventional fuel. The specific research objectives of the project include:

- Measure real-world, in-use duty cycles in North Carolina for specific types of nonroad vehicles, including backhoes, front-end loaders, and motor graders.
- Simultaneously measure real-world, in-use emissions.
- Develop modal emission factors.
- Develop representative duty cycles.
- Compare engine Tiers and B20 versus petroleum diesel based on real-world data.
- Conduct benchmark comparisons of average emission factors.